

**REMARKS**

Claims 1-18 and 27 are active in the case.

Applicants' representative wishes to thank Examiner Nguyen for the helpful and courteous interview of October 7, 2003. As a result of the discussion, it is believed that the issues in the case have been clarified and that the prosecution of the application has been materially advanced.

The present invention relates to a process for the upgrading of hydrocarbon mixtures that boil within the naphtha range and which contain sulfur impurities.

**Claim Amendments**

Claim 1 has been amended to the extent that it contains additional language which states that in the hydrogenation process, the ratio of olefin that has been hydrogenated to isomerized, non-hydrogenated olefin ranges from 0.7 to 2.5. The limits of the ratio range are taken from the data in Tables 2 to 4 of the specification, in particular, the experiment at 287° C in Table 3 and the experiment at 270° C in Table 4. Further, the definitions of the terms "HYD" and "ISO" in Claim 1 are supported by the text of the specification on page 19 where parameters of the invention are defined. Since the new or amending language in the claim is fully supported by the text of the application, the added matter to Claim 1 does not introduce new matter into the record. Entry of the amended claim is respectfully requested.

Claims 16 and 17 have been amended to make minor changes to a word in each claim. Entry of the amendments is respectfully requested.

Invention

As claimed, the present invention is a process of hydrodesulfurizing a hydrocarbon mixture, by reacting a hydrocarbon mixture containing olefins and having a boiling range within the range of  $C_4$  to  $250^{\circ} C$ , and a sulfur content of at least 150 ppm with hydrogen in the presence of a catalytic composition comprising:

a) an acidic carrier consisting of a silica and alumina gel, amorphous to X-rays, with a molar ratio  $SiO_2/Al_2O_3$  of 30/1 to 500/1, having a surface area ranging from 500 to 1000  $m^2/g$ , a porosity of 0.3 to 0.6 ml/g and a pore diameter within the range of 10-40 Å;

b) a mixture of metals belonging to Groups VIB and VIII of the Periodic Table deposited on the carrier in an overall quantity ranging from 2 to 67 % by weight with respect to the total amount of components (a) + (b), thereby effecting said hydrodesulfurization with concomitant skeletal isomerization of the olefins of said mixture under the hydrogenation conditions of the process which results in a ratio HYD/ISO ranging from 0.7 to 2.5, wherein HYD is the ratio of non-isomerized olefins that have been hydrogenated to olefins in the hydrocarbon mixture and ISO is the ratio of isomerized, hydrogenated and non-hydrogenated olefins to the sum of isomerized, hydrogenated and non-hydrogenated olefins and non-isomerized hydrogenated and non-hydrogenated olefins.

Applicants emphasize that the hydrocarbon mixture is one which boils within the stated range and is a mixture of both paraffinic hydrocarbons and olefins. In fact, a preferred embodiment of the hydrocarbon mixture is a full range naphtha having a boiling range of  $35^{\circ}$  -  $250^{\circ} C$ . As a result of contacting the hydrocarbon mixture with hydrogen in the presence of the catalyst as defined in the claims, not only is significant hydrodesulfurization of the

mixture obtained, but also importantly, from the viewpoint of obtaining a hydrocarbon product that exhibits a high octane rating, the olefin component of the hydrocarbon undergoes significant isomerization with minimal hydrogenation of the olefins to paraffinic material.

#### Prior Art Rejection

In the prosecution of the parent application the claims stood rejected based on 35 USC 103(a) as obvious over Hart U.S. Patent 3,156,640 in view of Bellussi et al EP-340868.

As applicants' representative maintained at the interview with the Examiner mentioned above, although the Hart patent discloses a process of hydrogenating a hydrocarbon material that contains olefins over a metal containing supported catalyst that achieves hydrodesulfurization of the hydrocarbon mixture, the hydrogenation that is accomplished not only removes sulfur, but also **extensively** results in the hydrogenation of olefins in the hydrocarbon starting material. The hydrogenation process is conducted in the presence of a catalyst as disclosed in column 4, lines 39-62 in which one or more sulfides of the metals of Group VI (Cr, Mo, W) and one or more sulfides of the metals of Group VIII (Fe, Co, Ni and noble metals) are supported on an acidic carrier of the likes of compounds of silica and alumina such as silica-alumina cracking catalyst. However, there is no teaching of suggestion of the specific acidic carrier of the present catalyst which is the silica/alumina gel as defined in subparagraph (a) of the claims. The patent at column 4, lines 63- 72 states that the olefins in the starting material are converted into branched or more highly branched olefins and/or paraffins, with the degree of saturation of the final product being dependent on

the composition of the catalyst and the reaction conditions. However, in the only example of a hydrodesulfurization/hydrogenation process disclosed in the reference at columns 5 and 6, the starting olefin containing material is **extensively** hydrogenated yielding a product that is practically free of olefins. There is no suggestion or teaching in the reference how the process can be so altered as to drastically favor olefin isomerization over olefin hydrogenation.

The failures of the reference are significant in light of comparative evidence provided by the examples of the text which describe the preparation of various catalyst formulations within the scope of the invention versus, in particular, two Examples, i.e., 11 and 12, that are comparative. Examples 8 to 10 of the application describe catalyst embodiments of the invention as used in hydrogenation reactions. Tables 2 to 4 of the text demonstrate the very superior ability of the catalyst system of the invention in promoting selective isomerization of olefins in the reacting starting material as opposed to significant hydrogenation of the isomerized olefin material to saturated product by virtue of the comparatively very low "HYD/ISO" ratios found in the three tables. On the other hand, for the comparative catalyst Catalyst F of Example 11, which is a combination of molybdenum and cobalt supported on  $\gamma$ -alumina in a commercially available catalyst and is thereby within the scope of catalysts shown in Hart, the columns ISO%, HYD% and HYD/ISO show a low content of isomerized unsaturates accompanied by extensive reduction of olefinic material to saturated hydrocarbons (high HYD/ISO ratio). A very similar situation is shown in Example 12 of the reference which is based on catalyst G which is a known Co/Mo catalyst in which the support

is acid silica/alumina gel. Very high HYD/ISO ratios are shown which indicate very significant hydrogenation of olefin in comparison to non-hydrogenated, isomerized olefin. Clearly, the Hart patent does not teach or suggest the present invention as claimed.

Applicants submit that the deficiencies of Hart are neither overcome nor improved upon by Bellussi et al. It is clear that the silica/alumina material disclosed in Bellussi et al is the same material which is used as the support for the catalytically active Group VIII and VIB metals used to prepare the catalyst system of the present invention which achieves the hydrodesulfurization results of the present invention. The Examiner had noted with respect to the disclosure in the publication that the catalyst system disclosed in the reference, which is the silica/alumina material described with no added metal, is useful in the catalysis of olefin isomerization reactions. However, the unsaturated feedstock employed by Bellussi et al selectively is an olefinic feedstock which is **not** the hydrocarbon mixture employed in the present process. Example 10 of the reference provides three specific examples of olefin feedstocks which are (1) 1-octene, (2) a mixture of linear isomers of tetradecene and (3) 7-tetradecene. The isomerization reaction does **not** occur in the presence of hydrogen. Moreover, whereas in the present process a significant degree of selectivity of olefin isomerization to isomeric unsaturated products is achieved while at the same time competing hydrogenation reactions that convert unsaturated material to isoparaffins and accomplish hydrogenative desulfurization of the feed to the reaction occur, no such competition occurs in the olefin isomerization reaction taught in Bellussi et al.

The Examiner had asserted that because the Hart patent teaches a catalyst in which catalytically active metal is supported on an acidic silica/alumina catalyst, one of skill in the

art would be led to substitute the silica/alumina gel of Bellussi et al for the known silica/alumina support materials shown in Hart to arrive at the present invention. However, applicants submit to the contrary that because of the significant level of activity of the acidic silica/alumina gel catalyst of the reference, one of skill in the art would expect that upon substitution of the silica/alumina gel catalyst of Bellussi et al for the silica/alumina supports disclosed by Hart, the resulting catalyst, when used in the process of Hart would, in the presence of hydrogen, exhibit **extensive hydrogenation** of olefins. The finding of the present invention, to the contrary, is that by using a catalyst in which Groups VIB and VIII metals are supported on the silica/alumina gel catalyst material of Bellussi et al, it is possible to **desulfurize** a mixture of hydrocarbons that contains olefins and sulfur, and at the same time achieve very significant skeletal isomerization of the olefin component of the hydrocarbon starting material of the present process **without** effecting significant hydrogenation of the olefins. Accordingly, applicants submit that the present invention is not obvious in view of the teachings of the combined references, and withdrawal of the rejection is respectfully requested.

Appl. No. 10/777,225  
Preliminary Amendment

It is now believed that the application is in proper condition for consideration on its merits.

Respectfully submitted,

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A handwritten signature in black ink, appearing to read 'F D Vastine', with a stylized flourish at the end.

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